Creating Conditionally EM-Permissive Metamaterial Layers with Dynamic Characteristics to Enable Programmatically Alterable Command Codes for Drone Control in Jammed Environments

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Introduction

Ibid. publication of 12 September 2023, there is a desire for a system for conditionally permitting certain patterns of electromagnetism in support of jamming prevention. In that publication, a crude concept for permitting EM-to-electricity conversion via semiconductor flakes bisecting an EM-blocking bi-layer was proposed. While that concept left many unanswered questions, that concept would have only been useful for supporting improved algorithmic noise reduction and would not have allowed for dynamical changes to the permitted patterns of electromagnetism.

Abstract

A combat drone can be made to function in a contested environment in a satisfactory capacity if a comparative handful of unique instructions may be sent in such a way that they may cut through jamming. About 24 or so unique commands such as *turn left, turn right, pull up, nose down, level off, fire, return to base* etc. would be needed for basic safe operation.

The right combination of metamaterials and system design could be leveraged in order to enable this number of unique commands to be received successfully by a drone while a metamaterial layer combined with a secondary mechanism would block all patterns of electromagnetism other than legitimate patterns. While prior attempts at preventing jamming have hinged around blocking ranges of frequencies, this approach revolves instead around selectively permitting complex patterns using solid-state mechanisms in conjunction with an atomic clock. Only the 24 intended patterns, in this system, would be capable of reaching the radio receiver. Furthermore, it is our goal to create a system which allows for the 24 whitelisted patterns to be mutable so that an adversary will not be able to use their knowledge of the legitimate codes in order to send malicious instructions.

Design

Not unlike graphene, which is insulative to electricity in the transverse direction and conductive in the parallel direction, EM-blocking metamaterials such as WSe_2/MoS_2 have the capacity to conduct electricity in the parallel direction and have an appreciable photovoltaic effect provided that the material is struck from the side angle.

Thus, if an aperture were deliberately left open and its width was matched to the phase height of the target frequency, interaction with EM of the target frequency would result in the generation of current. EM of a higher frequency (and thus, lesser phase height) could be expected to pass through the aperture and not be converted. Such EM would be blocked by the next successive layer, which would feature no gaps. EM of a lower frequency and thus greater phase height could be expected to be blocked by the outermost layer and not to be converted into electricity.

It is certainly possible for electromagnetism of some frequency other than the intended frequency to interact with the edges of one of the apertures, however, only the precise, intended frequency would be capable of contacting two edges of an aperture simultaneously and sending a synchronized current in two directions. In many ways, what we are proposing here is the inverse of what a stealth material mesh accomplishes. Whereas in an overlapping copperwire mesh regime, EM matched to the aperture size of the mesh is blocked and mesh every possible granularity is layered in order to block all possible frequencies, this layering would serve the purpose of converting only matched EM, insofar as is possible, into measurable current.

Apertures of every possible size, with each aperture being designed to correspond to a specific phase height of a frequency of radio wave one may wish to permit, would be incorporated into prefabricated sections of metamaterial. Each aperture would feature a conductive mechanism; perhaps a hydrogen nanowire; designed to carry generated current toward a measurement mechanism. Furthermore, each aperture would be backed by a movable hexagonal piece which fits precisely into the aperture. Pneumatic actuation could be used in order to literally snap these sections in and out of the apertures, with distances of movement being on the -nano scale.

With the vast majority of potential apertures containing their "stoppers" at any given time and thus being entirely closed, a minority of the electromagnetism striking the exposed edges of the EM-blocking layer would be successfully converted into electricity.

The final step in this process is to ascertain when a waveform is exactly matched with the target frequency by taking into consideration *only those impulses which are routed from a given aperture in two different directions (from two edges,) in femtosecond synchronization (offset by a half-wavelength, of course) as confirmed through precision timing mechanism.* This is the case for the reason that if an EM wave of precisely matched frequency were to strike two aperture edges precisely, current would be conveyed in multiple directions. Only in the case of an exact match would these two currents be in truly precise unison, although jammers may create many events which come close to perfect unison. Any time an electrical impulse is measured coming from the same aperture wherein pulse A is received at a relative offset of timing with respect to pulse B equal to precisely the length of time it would require that frequency of EM to undergo a single half-phase (1/60th of one billionth of one second for a 30GHz

signal) then it could be reasonably inferred that EM of the target frequency has been received.

Precision chronometry is necessary both for identifying when current is simultaneously generated in two directions from the same nano-aperture as well as for identifying when sequences of EM are received in the proper order. Thus, a bi-directional, half-phase-timing offset current originating from a single aperture fulfills the first conditional "if" statement which must be met to verify a candidate waveform. This would need to be followed up with a second, third, and fourth matching candidate signal within the expected time frame. 24 distinct patterns would be measurable through the opening of four apertures and by listening for four successive waveforms of the correct frequency received in the proper sequence. Furthermore, the system would require that an authentic signal pattern be received three times before acting on a command in order to entirely rule out the possibility of a coincidence. Once a command signal has been received, it may not be re-used and the pneumatic actuators impose a new security regime.

Conclusion

As much of the proverbial heavy lifting of noise elimination is performed by a solid-state mechanism in this regime and the remaining work revolves around the measurement of pulse timing, it makes the signal authentication task far simpler than it is for those systems which rely upon traditional signal analysis.